A Space and Solar Physics Great Observatory: Virtual but Nearing Reality

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Why a Great Observatory?

- Progress in space and solar physics increasingly depends on multispacecraft and spacecraft/model integration.
- We now have many resources online, but in many places and in different formats.
- To solve problems such as those posed by the Living With a Star Program, a new paradigm is needed in which the various observational and computational resources are easily accessible in a uniform way.

Definition of a "Virtual Observatory"

A Virtual Observatory (VO) is a suite of software applications on a set of computers that allows users to uniformly find, access, and use resources (data, software, document, and image products and services using these) from a collection of distributed product repositories and service providers.

A VO is a service that unites services and/or multiple repositories.

Purpose of VOs

- Make "standard" scientific research much more efficient.
  - Even the PI teams should want to use them.
  - Must improve on existing services (Mission and PI sites, CDAWeb, etc.). VOs will not replace these, but will use them in new ways.

- Enable new, global problems to be solved (make a "Great Observatory")
  - Rapidly gain integrated views from the solar origin to the terrestrial effects of an event.
  - Find data related to any particular observation.
  - (Ultimately) answer "higher-order" queries such as "Show me the data from cases where a large CME observed by SOHO was also observed *in situ*."

Tasks for a VO Data Environment

- Produce and make openly publicly available complete, high-quality data products and basic software to use them.
  - This is the core of the data environment.
  - Automated data reduction is key, and should be supported.
  - Open, public availability makes the user part of the data-quality effort; for some this is new. An open-data policy is generally good for providers.

- Register the resources (products and services) in a uniform language.
  - A community accepted "data model" provides the required semantics.
  - A general registry ("metadata library") with web-based entry and easy export could keep track of additions and changes.
  - Product IDs can help a great deal to simplify access and use.

Tasks for a VO Data Environment (cont.)

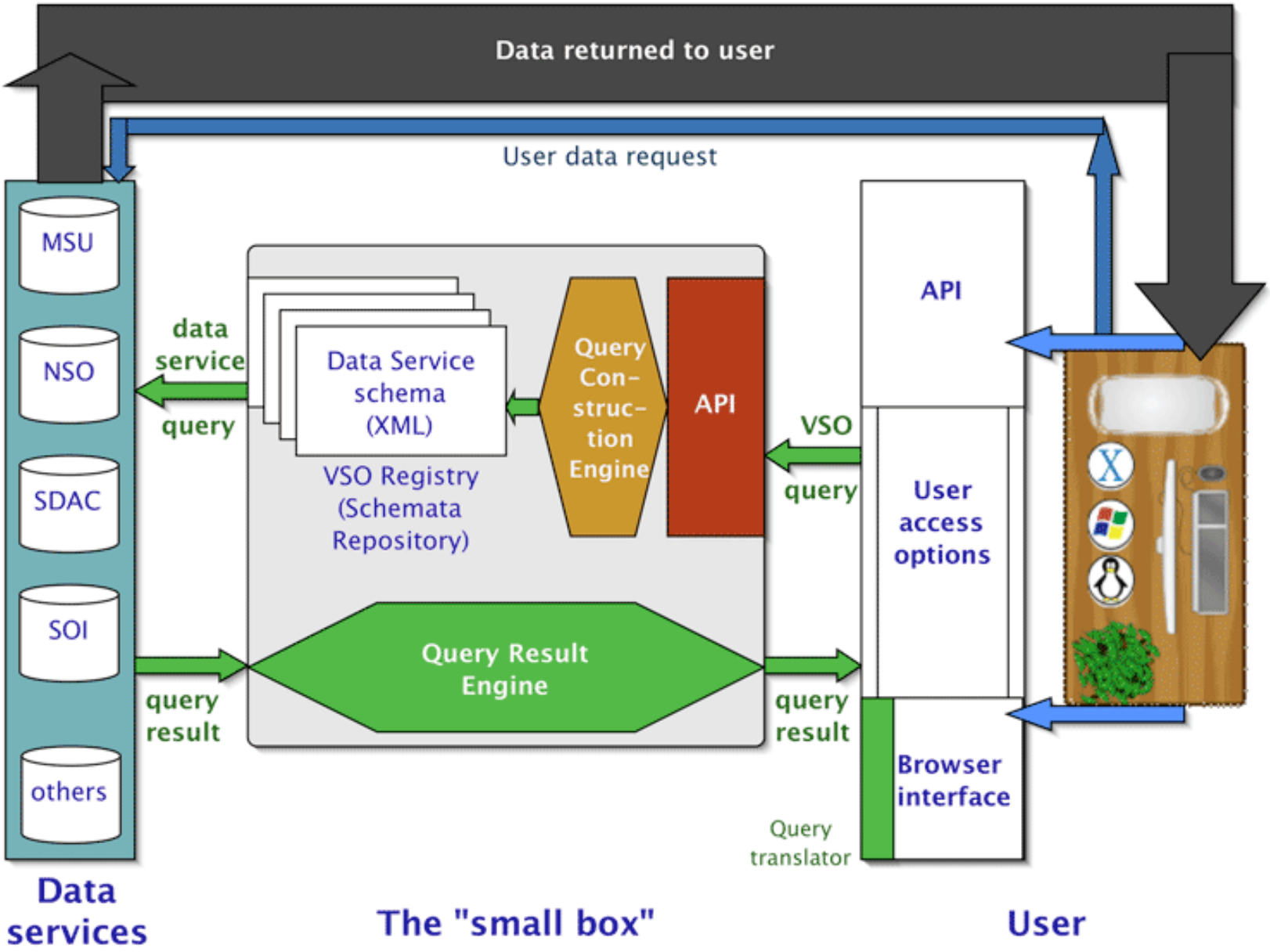
- Provide direct machine access, preferably using the above uniform language, to the resources. Provide APIs to make access easier.
  - A common set of protocols (e.g., "SOAP", cgi, ftp standards) would help.
  - "VxOs" can organize subfields.

- Develop tools to find and access the resources ("gateways/brokers") using the registry and the access methods.
  - Produce APIs that allow applications to use these tools.
  - Provide "default" front-end applications.

Tasks for a VO Data Environment (cont.)

- Develop applications and services to use data products.
  - Applications can be downloaded, repository provided (e.g., graphics and subsetting), or web service accessible (e.g., SolarSoft via CoSEC)
  - Some useful services: running "on-demand" models; reading, displaying, and translating multiple formats; transformating coordinates; merging related datasets and performing correlations; browsing data plots.

- Enable "higher-order" queries using "pre-mining" of data to produce event lists and modest resolution datasets.
  - We want to ask things like, "When were there solar flares, strong geomagnetic activity, and spacecraft both upstream of the Earth and in the magnetotail?"
  - Direct data mining will be possible only in special cases.


Data returned to user
User data request
MSU
NSO
SDAC
SOI
others
data service
query
Data Service schema (XML)
VSO Registry (Schemata Repository)
Query Con-struc-tion Engine
API
VSO
query
API
User access options
Query Result Engine
query result
query result
Browser interface
Query translator
Data services
The "small box"
User

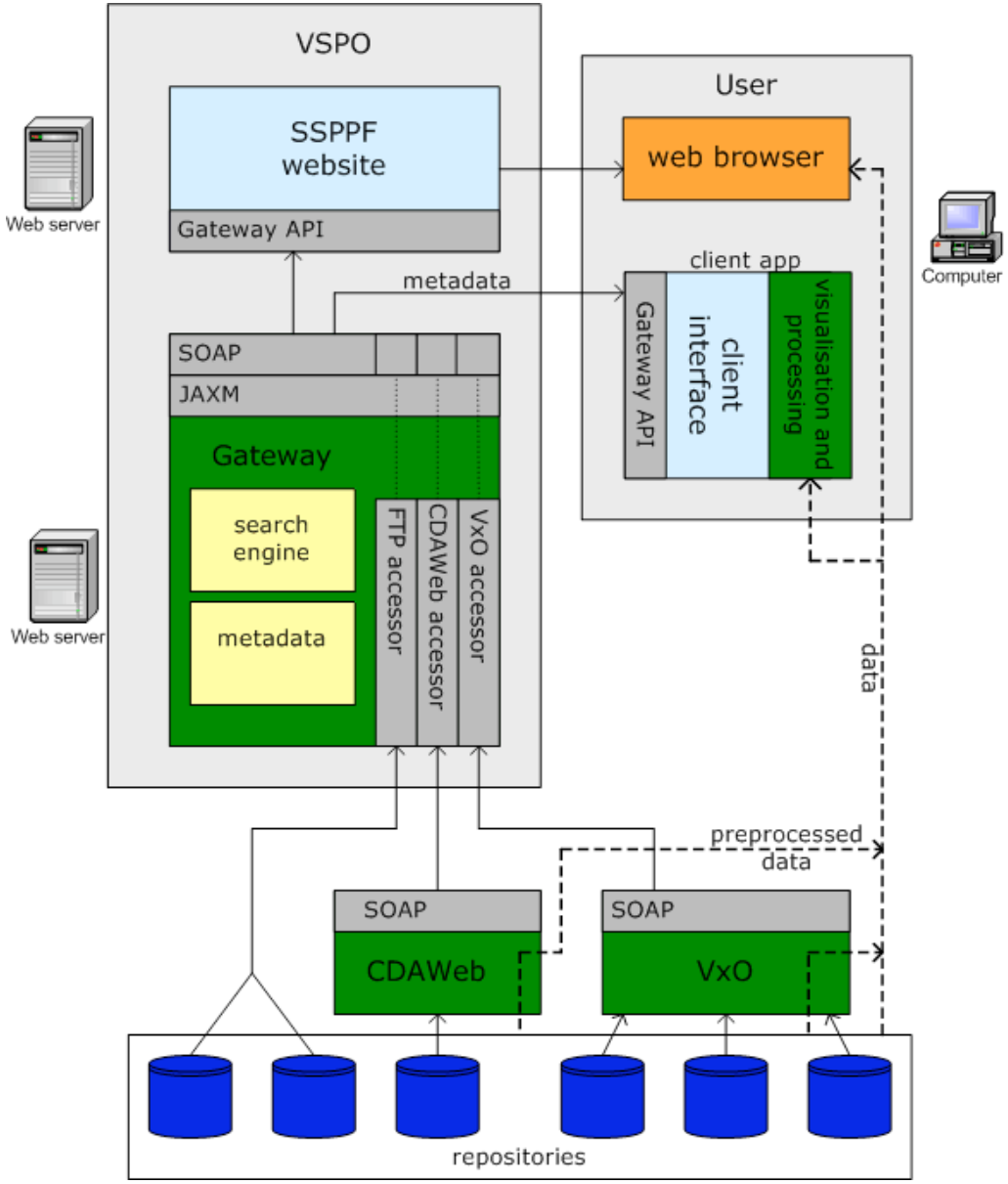
A “large box”:

Broader but less uniform access.

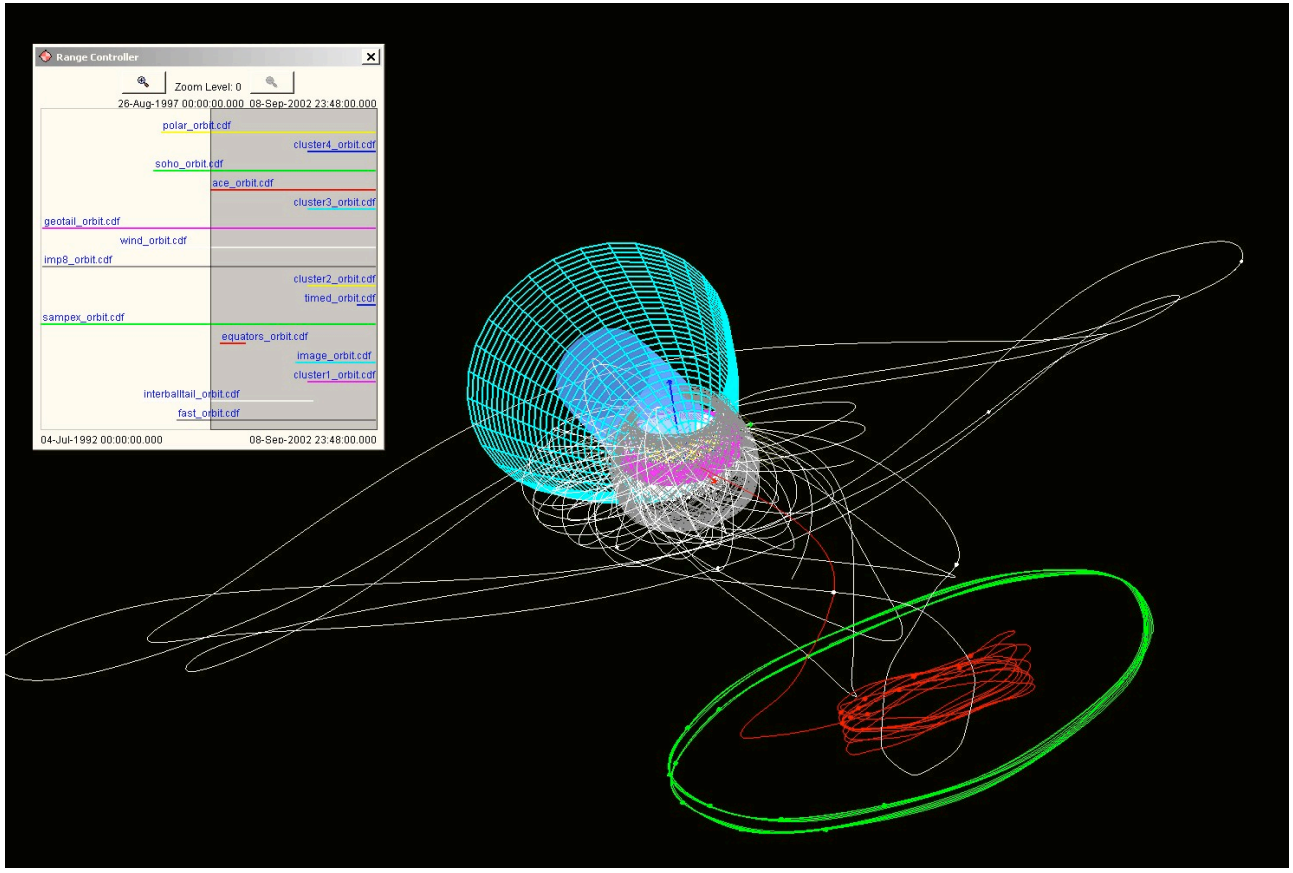
“Product” oriented.

Iterative search interface.

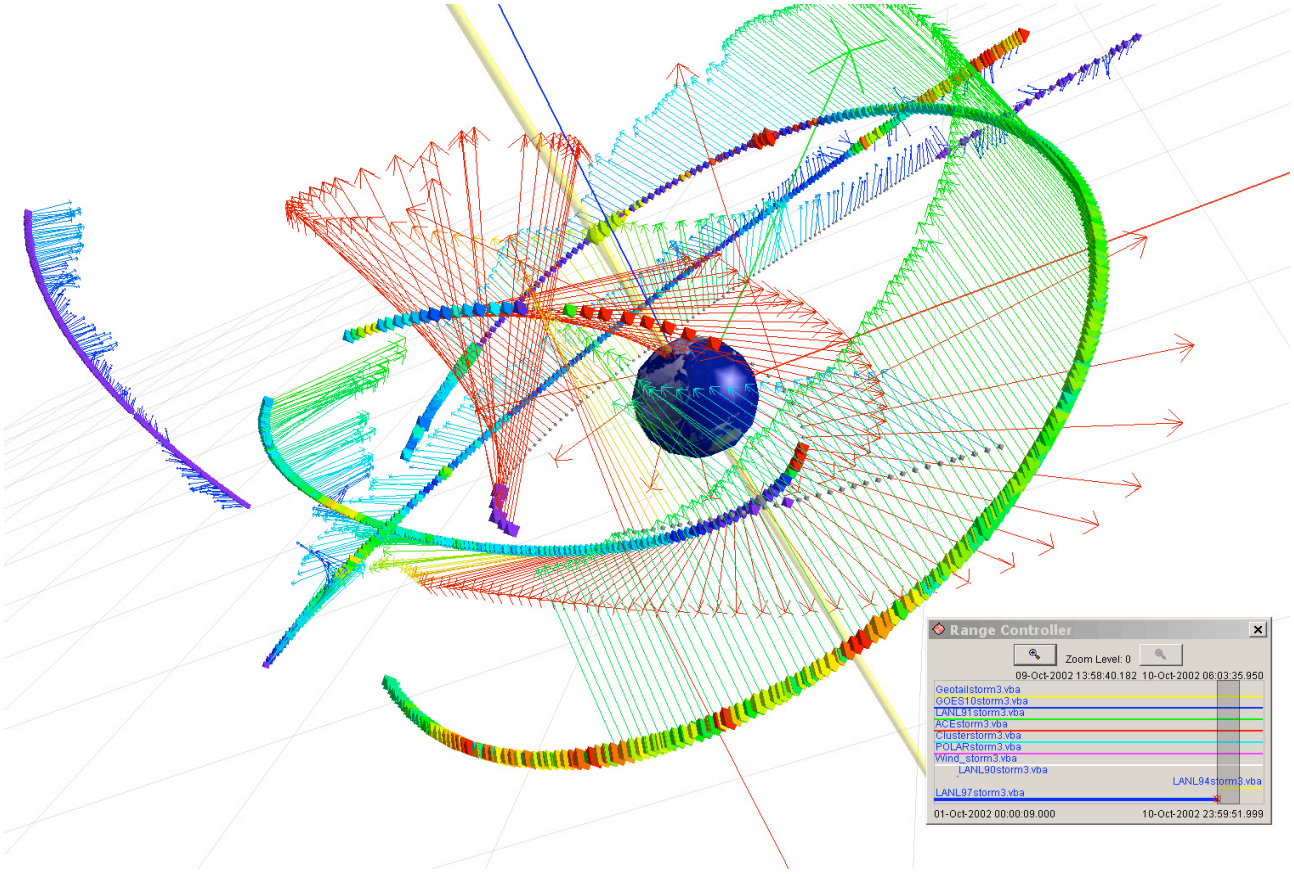
Much the same basic structure.



ViSBARD Orbits



ViSBARD Magnetospheric Data Viewing



A First “Large Box”: Science Use and Internal Structure (Virtual Space Physics Observatory)

Primary developers:

Aaron Roberts, NASA/GSFC

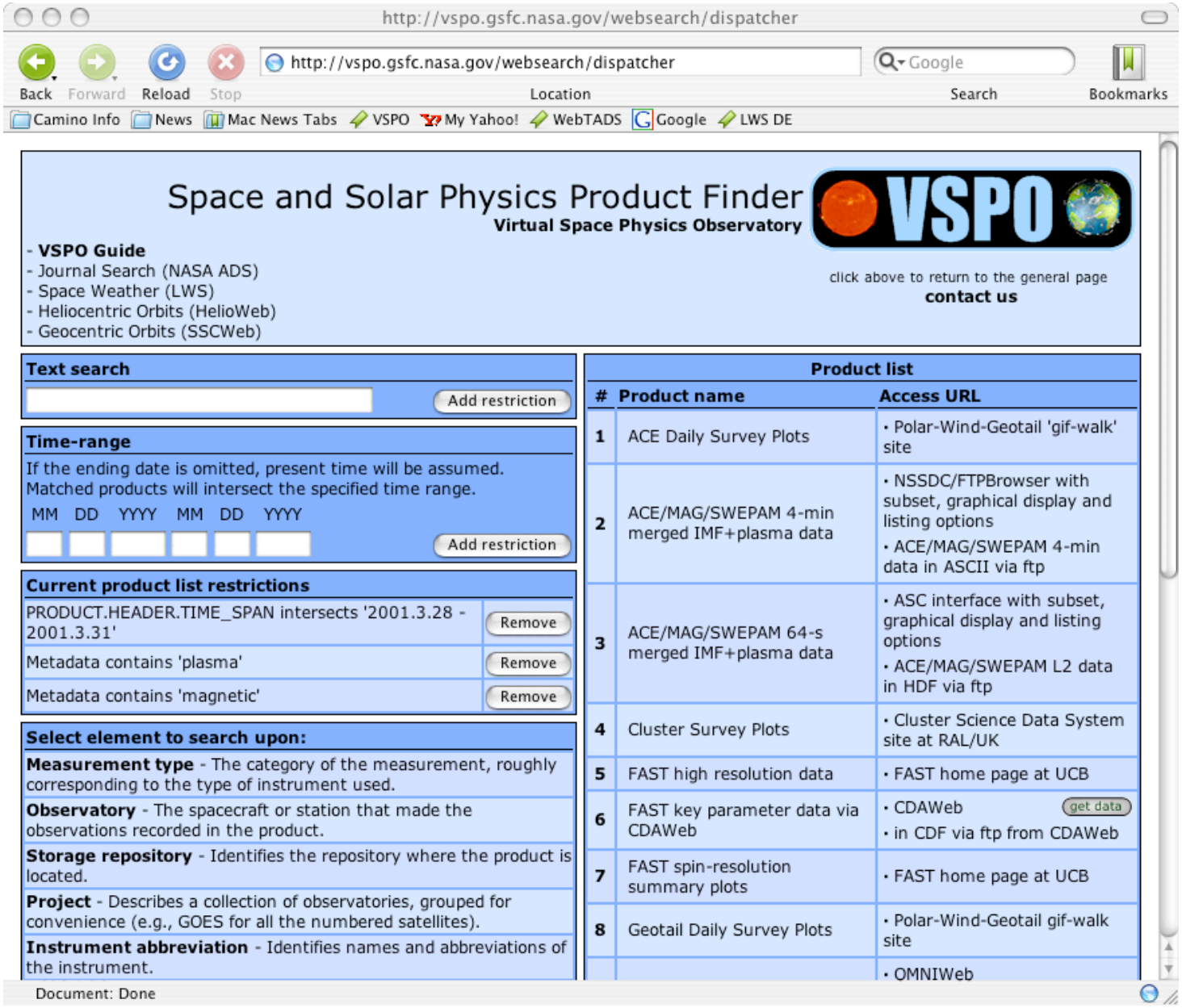
Vasili Rezapkin, Aquilent

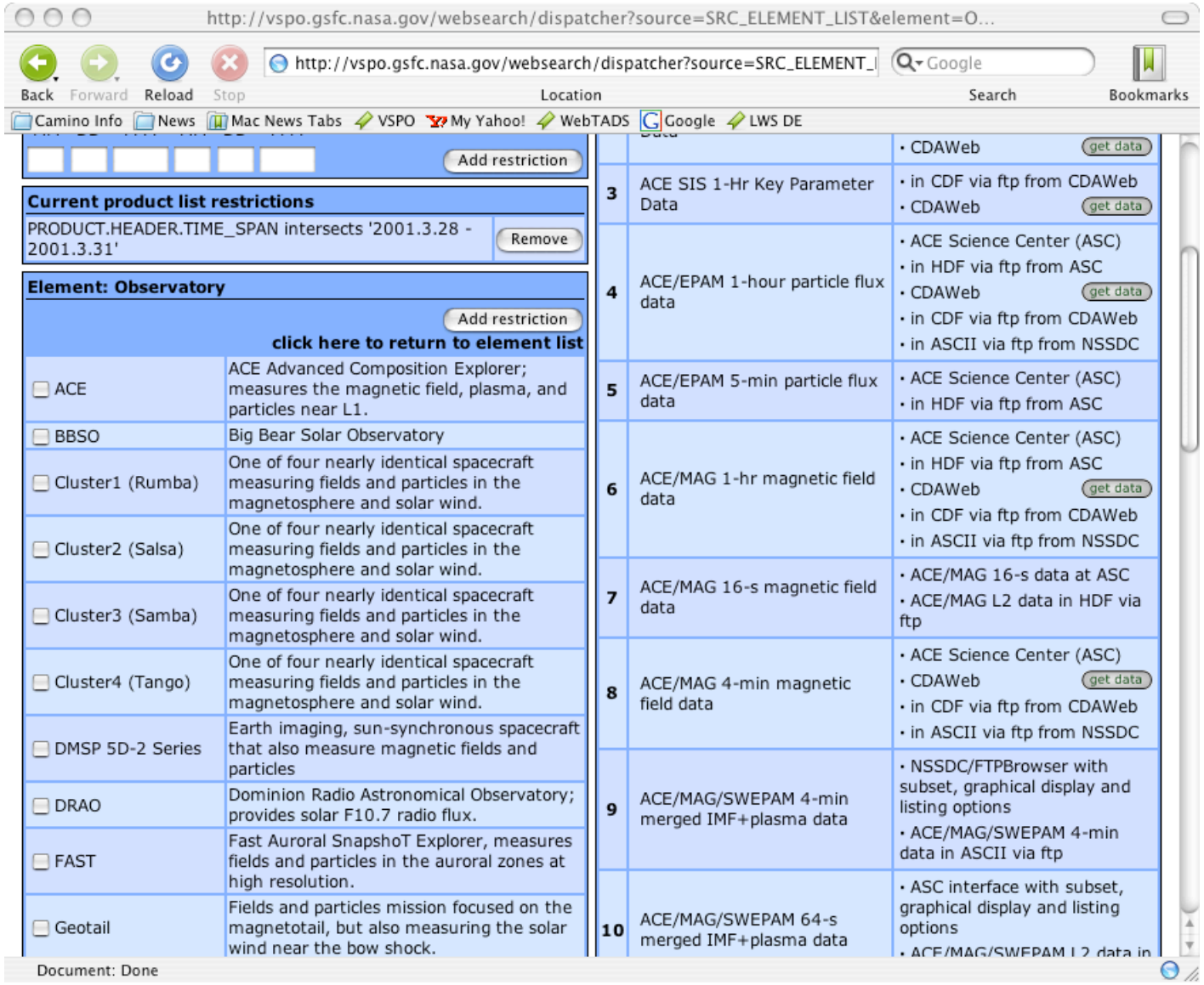
Joe King, QSS

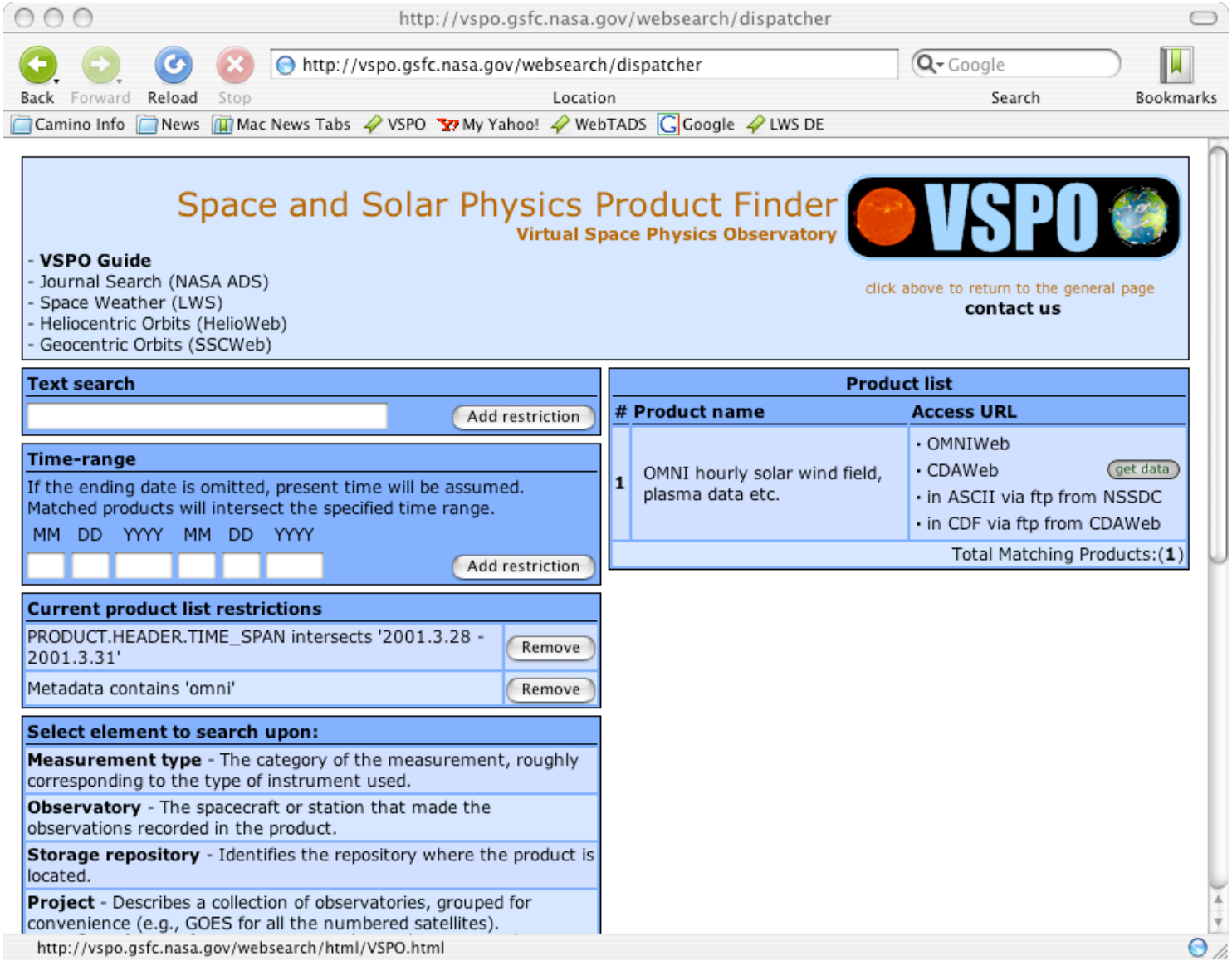
Now connected to LWS, SPASE, CDAWeb, and, less directly, to VSO and VHO, as well as SBIR and other projects such as ViSBARD.

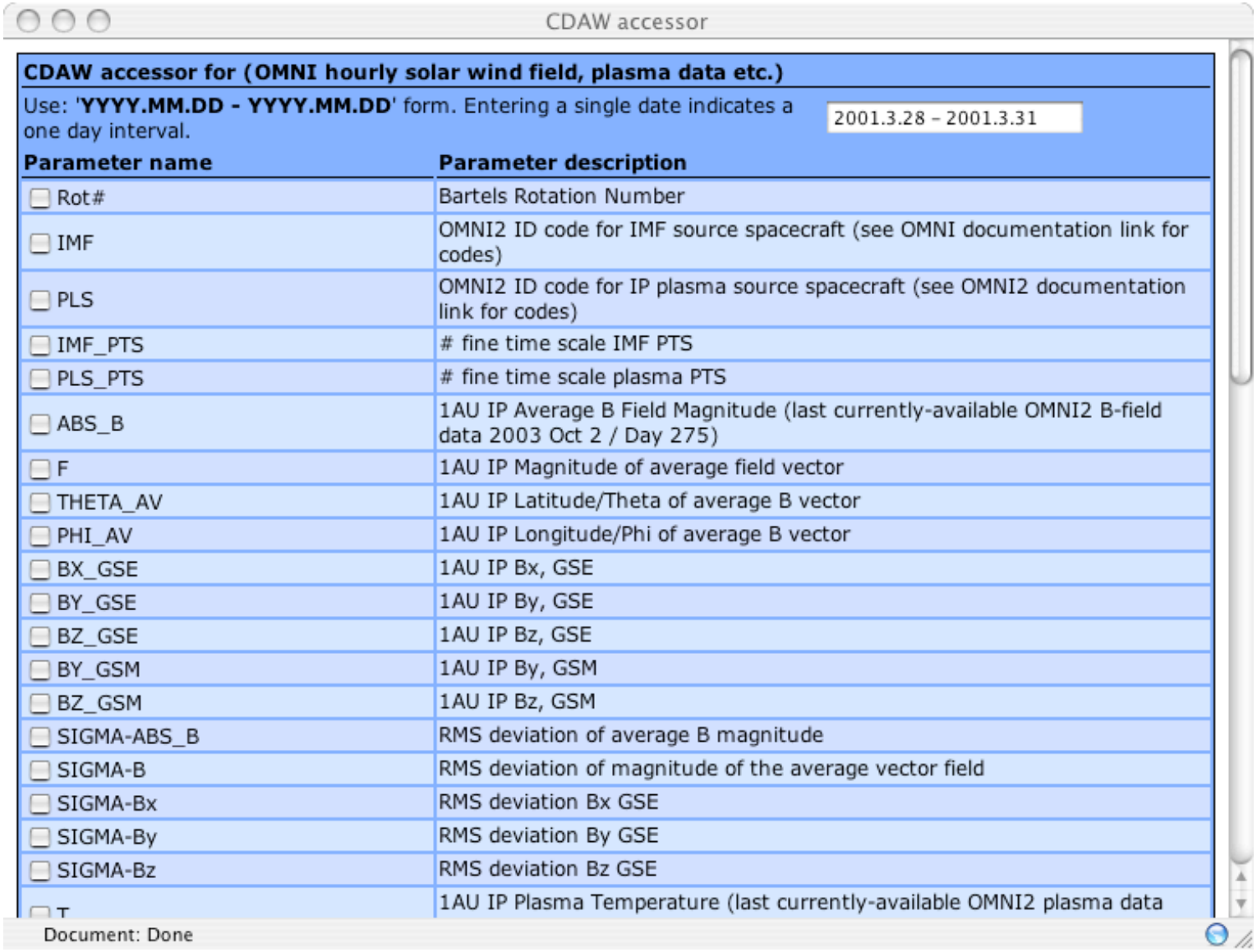
Overview

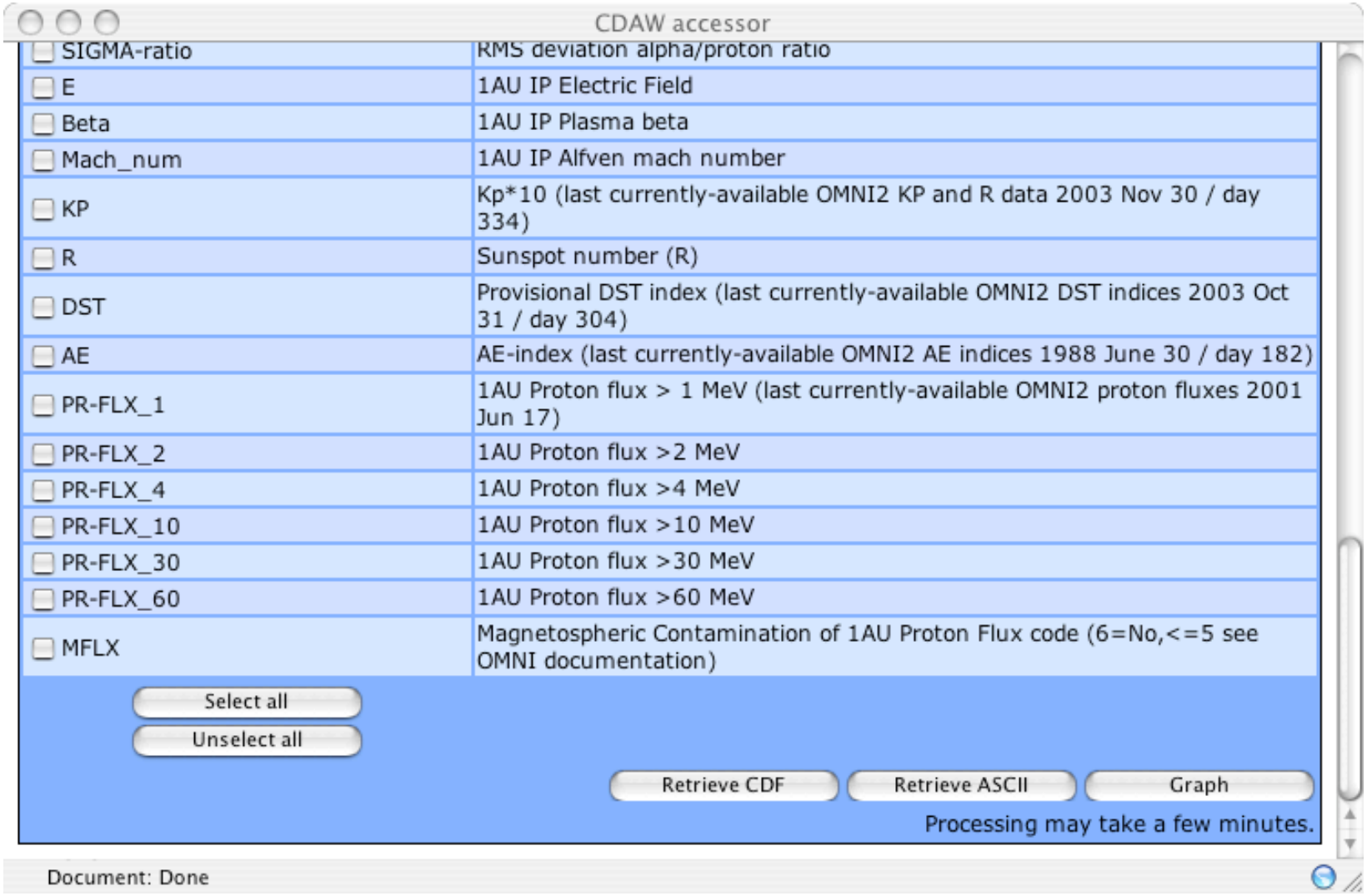
- VSPO is designed to provide access to a wide variety of data, image, model, and other products or URLs to sites that deliver these products. ("Three clicks from data.")
- A dynamic web page front end allows "Google-like" and element-based searches for products.
- "SOAP" interfaces pass internal messages, and are used for direct repository access. Other protocols for the latter (e.g., ftp) will be implemented.
- Additional service links (for orbits, references, and current space weather) are provided for convenience.


http://vspo.gsfc.nasa.gov/websearch/dispatcher
Back
Forward
Reload
Stop
http://vspo.gsfc.nasa.gov/websearch/dispatcher
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
Space and Solar Physics Product Finder
Virtual Space Physics Observatory
VSPO
- VSPO Guide
- Journal Search (NASA ADS)
- Space Weather (LWS)
- Heliocentric Orbits (HelioWeb)
- Geocentric Orbits (SSCWeb)
click above to return to the general page
contact us
Text search
Add restriction
Time-range
If the ending date is omitted, present time will be assumed.
Matched products will intersect the specified time range.
MM DD YYYY MM DD YYYY
Add restriction
Current product list restrictions
PRODUCT.HEADER.TIME_SPAN intersects '2001.3.28 - 2001.3.31'
Remove
Metadata contains 'plasma'
Remove
Metadata contains 'magnetic'
Remove
Select element to search upon:
Measurement type - The category of the measurement, roughly corresponding to the type of instrument used.
Observatory - The spacecraft or station that made the observations recorded in the product.
Storage repository - Identifies the repository where the product is located.
Project - Describes a collection of observatories, grouped for convenience (e.g., GOES for all the numbered satellites).
Instrument abbreviation - Identifies names and abbreviations of the instrument.
Product list
Product name Access URL
1 ACE Daily Survey Plots • Polar-Wind-Geotail 'gif-walk' site
2 ACE/MAG/SWEPAM 4-min merged IMF+plasma data • NSSDC/FTPBrowser with subset, graphical display and listing options • ACE/MAG/SWEPAM 4-min data in ASCII via ftp
3 ACE/MAG/SWEPAM 64-s merged IMF+plasma data • ASC interface with subset, graphical display and listing options • ACE/MAG/SWEPAM L2 data in HDF via ftp
4 Cluster Survey Plots • Cluster Science Data System site at RAL/UK
5 FAST high resolution data • FAST home page at UCB
6 FAST key parameter data via CDAWeb • CDAWeb get data • in CDF via ftp from CDAWeb
7 FAST spin-resolution summary plots • FAST home page at UCB
8 Geotail Daily Survey Plots • Polar-Wind-Geotail gif-walk site
• OMNIWeb
Document: Done

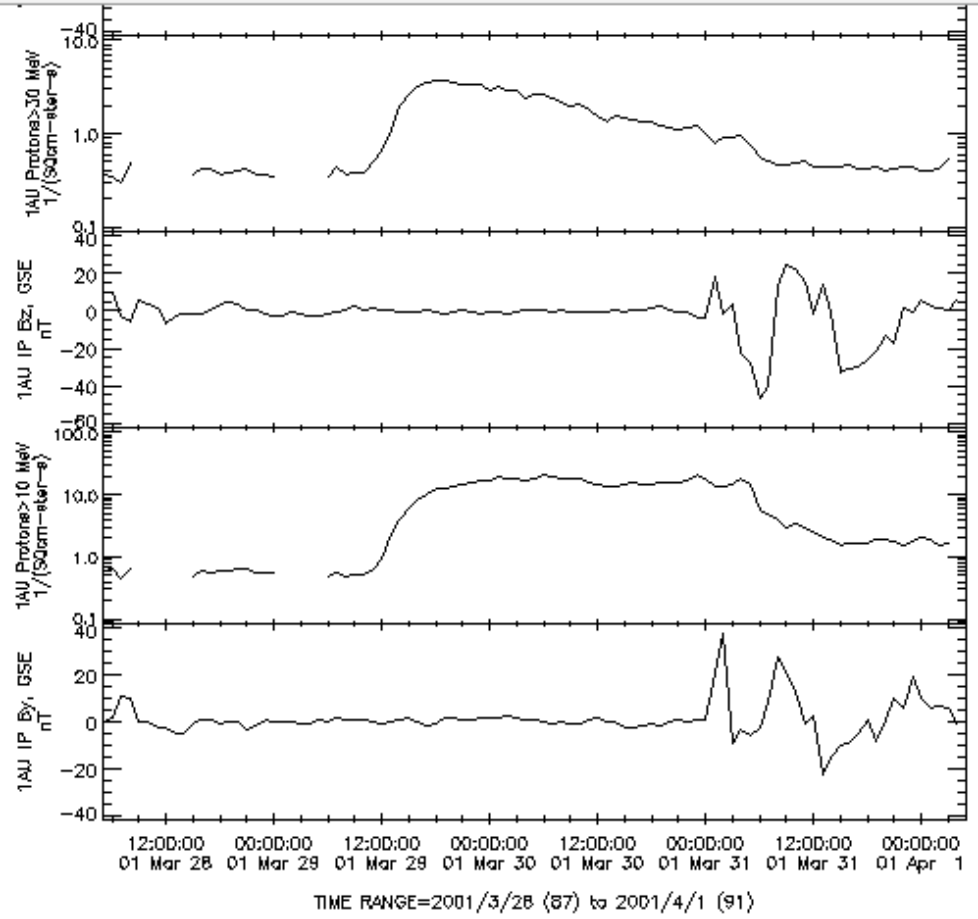

http://vspo.gsfc.nasa.gov/websearch/dispatcher?source=SRC_ELEMENT_LIST&element=O...
Back
Forward
Reload
Stop
http://vspo.gsfc.nasa.gov/websearch/dispatcher?source=SRC_ELEMENT_
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
Add restriction
Current product list restrictions
PRODUCT.HEADER.TIME_SPAN intersects '2001.3.28 - 2001.3.31'
Remove
Element: Observatory
Add restriction
click here to return to element list
ACE
ACE Advanced Composition Explorer; measures the magnetic field, plasma, and particles near L1.
BBSO
Big Bear Solar Observatory
Cluster1 (Rumba)
One of four nearly identical spacecraft measuring fields and particles in the magnetosphere and solar wind.
Cluster2 (Salsa)
One of four nearly identical spacecraft measuring fields and particles in the magnetosphere and solar wind.
Cluster3 (Samba)
One of four nearly identical spacecraft measuring fields and particles in the magnetosphere and solar wind.
Cluster4 (Tango)
One of four nearly identical spacecraft measuring fields and particles in the magnetosphere and solar wind.
DMSP 5D-2 Series
Earth imaging, sun-synchronous spacecraft that also measure magnetic fields and particles
DRAO
Dominion Radio Astronomical Observatory; provides solar F10.7 radio flux.
FAST
Fast Auroral SnapshoT Explorer, measures fields and particles in the auroral zones at high resolution.
Geotail
Fields and particles mission focused on the magnetotail, but also measuring the solar wind near the bow shock.
• CDAWeb get data
3
ACE SIS 1-Hr Key Parameter Data
• in CDF via ftp from CDAWeb
• CDAWeb get data
4
ACE/EPAM 1-hour particle flux data
• ACE Science Center (ASC)
• in HDF via ftp from ASC
• CDAWeb get data
• in CDF via ftp from CDAWeb
• in ASCII via ftp from NSSDC
5
ACE/EPAM 5-min particle flux data
• ACE Science Center (ASC)
• in HDF via ftp from ASC
6
ACE/MAG 1-hr magnetic field data
• ACE Science Center (ASC)
• in HDF via ftp from ASC
• CDAWeb get data
• in CDF via ftp from CDAWeb
• in ASCII via ftp from NSSDC
7
ACE/MAG 16-s magnetic field data
• ACE/MAG 16-s data at ASC
• ACE/MAG L2 data in HDF via ftp
8
ACE/MAG 4-min magnetic field data
• ACE Science Center (ASC)
• CDAWeb get data
• in CDF via ftp from CDAWeb
• in ASCII via ftp from NSSDC
9
ACE/MAG/SWEPAM 4-min merged IMF+plasma data
• NSSDC/FTPBrowser with subset, graphical display and listing options
• ACE/MAG/SWEPAM 4-min data in ASCII via ftp
10
ACE/MAG/SWEPAM 64-s merged IMF+plasma data
• ASC interface with subset, graphical display and listing options
Document: Done


http://vspo.gsfc.nasa.gov/websearch/dispatcher
Back
Forward
Reload
Stop
http://vspo.gsfc.nasa.gov/websearch/dispatcher
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
Space and Solar Physics Product Finder
Virtual Space Physics Observatory
VSPO
- VSPO Guide
- Journal Search (NASA ADS)
- Space Weather (LWS)
- Heliocentric Orbits (HelioWeb)
- Geocentric Orbits (SSCWeb)
click above to return to the general page
contact us
Text search
Add restriction
Time-range
If the ending date is omitted, present time will be assumed.
Matched products will intersect the specified time range.
MM DD YYYY MM DD YYYY
Add restriction
Current product list restrictions
PRODUCT.HEADER.TIME_SPAN intersects '2001.3.28 - 2001.3.31'
Remove
Metadata contains 'omni'
Remove
Select element to search upon:
Measurement type - The category of the measurement, roughly corresponding to the type of instrument used.
Observatory - The spacecraft or station that made the observations recorded in the product.
Storage repository - Identifies the repository where the product is located.
Project - Describes a collection of observatories, grouped for convenience (e.g., GOES for all the numbered satellites).
Product list
Product name
Access URL
1
OMNI hourly solar wind field, plasma data etc.
• OMNIWeb
• CDAWeb
get data
• in ASCII via ftp from NSSDC
• in CDF via ftp from CDAWeb
Total Matching Products:(1)
http://vspo.gsfc.nasa.gov/websearch/html/VSPO.html


CDAW accessor
CDAW accessor for (OMNI hourly solar wind field, plasma data etc.)
Use: 'YYYY.MM.DD - YYYY.MM.DD' form. Entering a single date indicates a one day interval.
2001.3.28 – 2001.3.31
Parameter name
Parameter description
Rot#
Bartels Rotation Number
IMF
OMNI2 ID code for IMF source spacecraft (see OMNI documentation link for codes)
PLS
OMNI2 ID code for IP plasma source spacecraft (see OMNI2 documentation link for codes)
IMF_PTS
fine time scale IMF PTS
PLS_PTS
fine time scale plasma PTS
ABS_B
1AU IP Average B Field Magnitude (last currently-available OMNI2 B-field data 2003 Oct 2 / Day 275)
F
1AU IP Magnitude of average field vector
THETA_AV
1AU IP Latitude/Theta of average B vector
PHI_AV
1AU IP Longitude/Phi of average B vector
BX_GSE
1AU IP Bx, GSE
BY_GSE
1AU IP By, GSE
BZ_GSE
1AU IP Bz, GSE
BY_GSM
1AU IP By, GSM
BZ_GSM
1AU IP Bz, GSM
SIGMA-ABS_B
RMS deviation of average B magnitude
SIGMA-B
RMS deviation of magnitude of the average vector field
SIGMA-Bx
RMS deviation Bx GSE
SIGMA-By
RMS deviation By GSE
SIGMA-Bz
RMS deviation Bz GSE
T
1AU IP Plasma Temperature (last currently-available OMNI2 plasma data
Document: Done


CDAW accessor
SIGMA-ratio
RMS deviation alpha/proton ratio
E
1AU IP Electric Field
Beta
1AU IP Plasma beta
Mach_num
1AU IP Alfven mach number
KP
Kp*10 (last currently-available OMNI2 KP and R data 2003 Nov 30 / day 334)
R
Sunspot number (R)
DST
Provisional DST index (last currently-available OMNI2 DST indices 2003 Oct 31 / day 304)
AE
AE-index (last currently-available OMNI2 AE indices 1988 June 30 / day 182)
PR-FLX_1
1AU Proton flux > 1 MeV (last currently-available OMNI2 proton fluxes 2001 Jun 17)
PR-FLX_2
1AU Proton flux >2 MeV
PR-FLX_4
1AU Proton flux >4 MeV
PR-FLX_10
1AU Proton flux >10 MeV
PR-FLX_30
1AU Proton flux >30 MeV
PR-FLX_60
1AU Proton flux >60 MeV
MFLX
Magnetospheric Contamination of 1AU Proton Flux code (6=No,<=5 see OMNI documentation)
Select all
Unselect all
Retrieve CDF
Retrieve ASCII
Graph
Processing may take a few minutes.
Document: Done

CDAW accessor results



TIME RANGE=2001/3/28 (87) to 2001/4/1 (91)

Please acknowledge data provider, J.H. King at NSSDC @ NASA's GSFC and CDAWeb when using these data.
Generated by CDAWeb on Sun Oct 24 14:20:15 2004

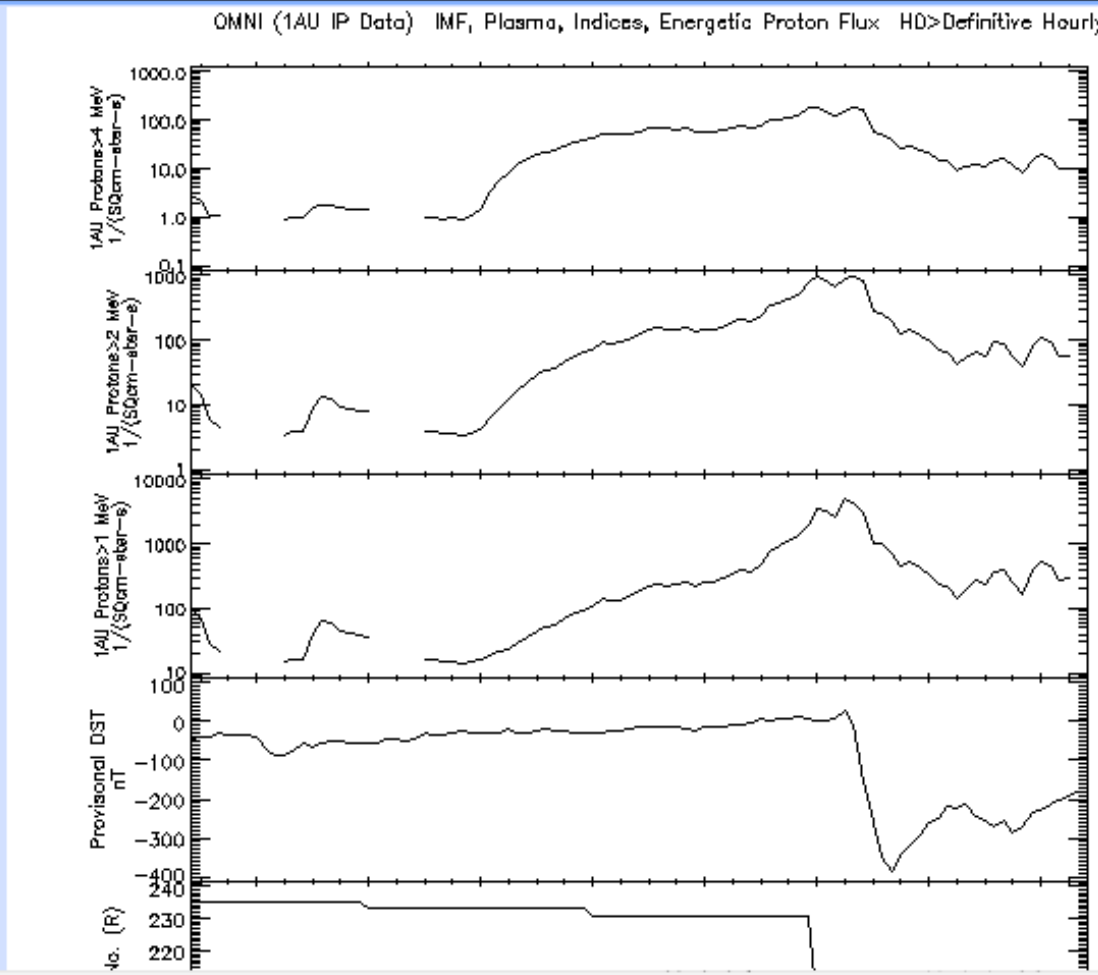
click here to return to accessor prompt

Document: Done

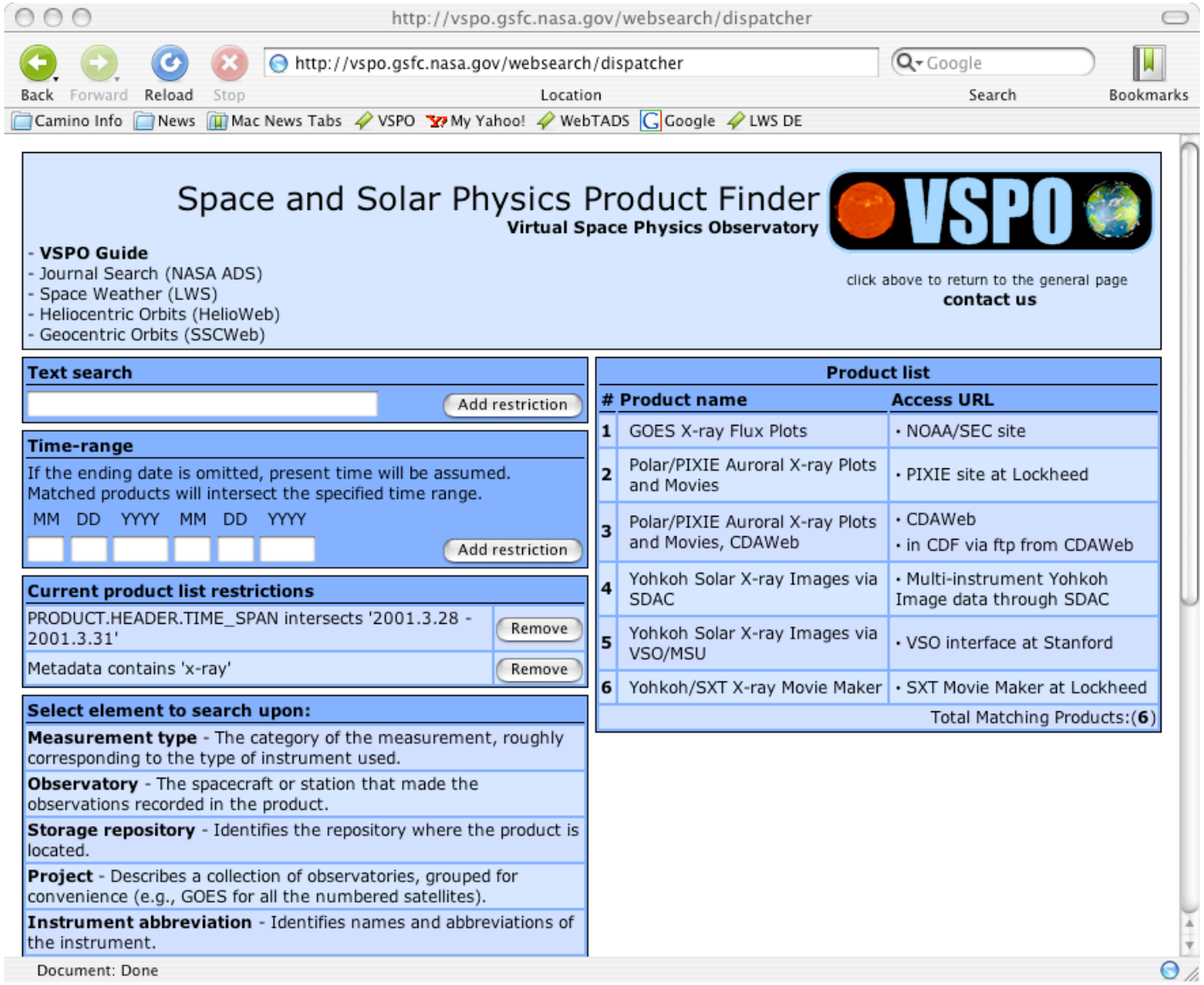
CDAW accessor results

OMNI hourly solar wind field, plasma data etc.

Images



Document: Done


http://vspo.gsfc.nasa.gov/websearch/dispatcher
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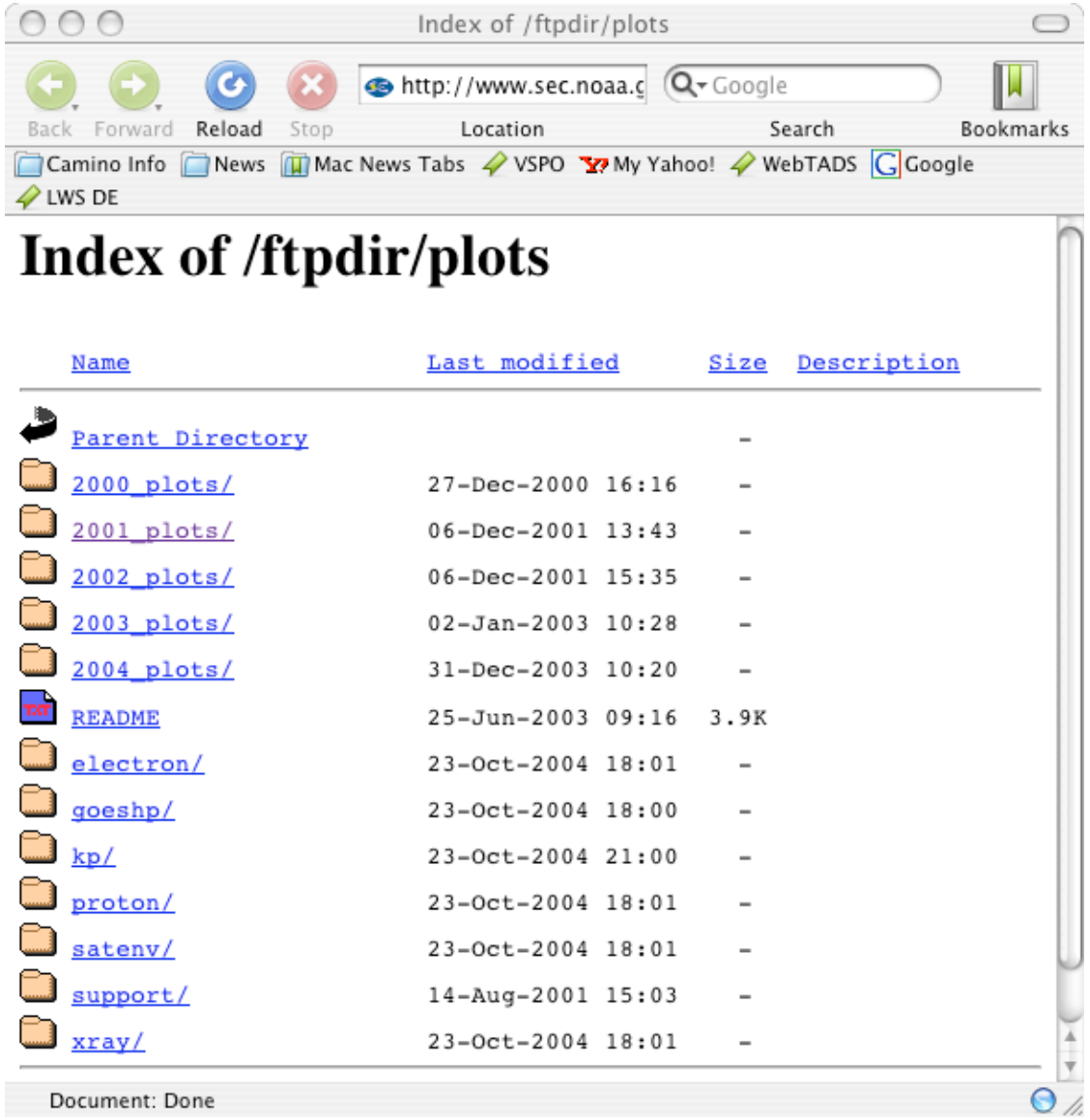
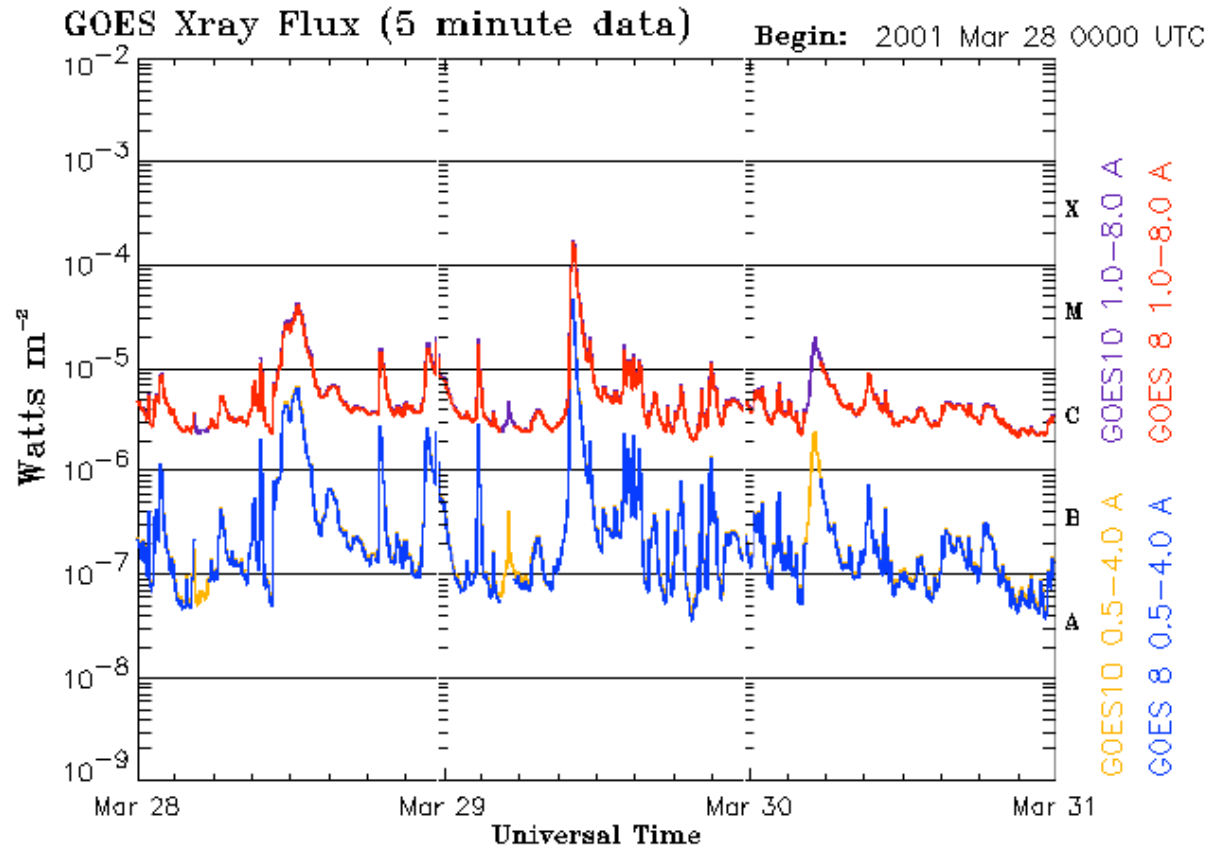
Forward
Reload
Stop
http://vspo.gsfc.nasa.gov/websearch/dispatcher
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
Space and Solar Physics Product Finder
Virtual Space Physics Observatory
VSPO
- VSPO Guide
- Journal Search (NASA ADS)
- Space Weather (LWS)
- Heliocentric Orbits (HelioWeb)
- Geocentric Orbits (SSCWeb)
click above to return to the general page
contact us
Text search
Add restriction
Time-range
If the ending date is omitted, present time will be assumed.
Matched products will intersect the specified time range.
MM DD YYYY MM DD YYYY
Add restriction
Current product list restrictions
PRODUCT.HEADER.TIME_SPAN intersects '2001.3.28 - 2001.3.31'
Remove
Metadata contains 'x-ray'
Remove
Select element to search upon:
Measurement type - The category of the measurement, roughly corresponding to the type of instrument used.
Observatory - The spacecraft or station that made the observations recorded in the product.
Storage repository - Identifies the repository where the product is located.
Project - Describes a collection of observatories, grouped for convenience (e.g., GOES for all the numbered satellites).
Instrument abbreviation - Identifies names and abbreviations of the instrument.
Product list
Product name Access URL
1 GOES X-ray Flux Plots • NOAA/SEC site
2 Polar/PIXIE Auroral X-ray Plots and Movies • PIXIE site at Lockheed
3 Polar/PIXIE Auroral X-ray Plots and Movies, CDAWeb • CDAWeb • in CDF via ftp from CDAWeb
4 Yohkoh Solar X-ray Images via SDAC • Multi-instrument Yohkoh Image data through SDAC
5 Yohkoh Solar X-ray Images via VSO/MSU • VSO interface at Stanford
6 Yohkoh/SXT X-ray Movie Maker • SXT Movie Maker at Lockheed
Total Matching Products:(6)
Document: Done


Index of /ftpdir/plots
Back
Forward
Reload
Stop
http://www.sec.noaa.g
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
Index of /ftpdir/plots
Name
Last modified
Size
Description
Parent Directory -
2000_plots/ 27-Dec-2000 16:16 -
2001_plots/ 06-Dec-2001 13:43 -
2002_plots/ 06-Dec-2001 15:35 -
2003_plots/ 02-Jan-2003 10:28 -
2004_plots/ 31-Dec-2003 10:20 -
README 25-Jun-2003 09:16 3.9K
electron/ 23-Oct-2004 18:01 -
goeshp/ 23-Oct-2004 18:00 -
kp/ 23-Oct-2004 21:00 -
proton/ 23-Oct-2004 18:01 -
satenv/ 23-Oct-2004 18:01 -
support/ 14-Aug-2001 15:03 -
xray/ 23-Oct-2004 18:01 -
Document: Done

20010330_xray.gif (GIF Image, 640x480 pixels) – Scaled (99%)

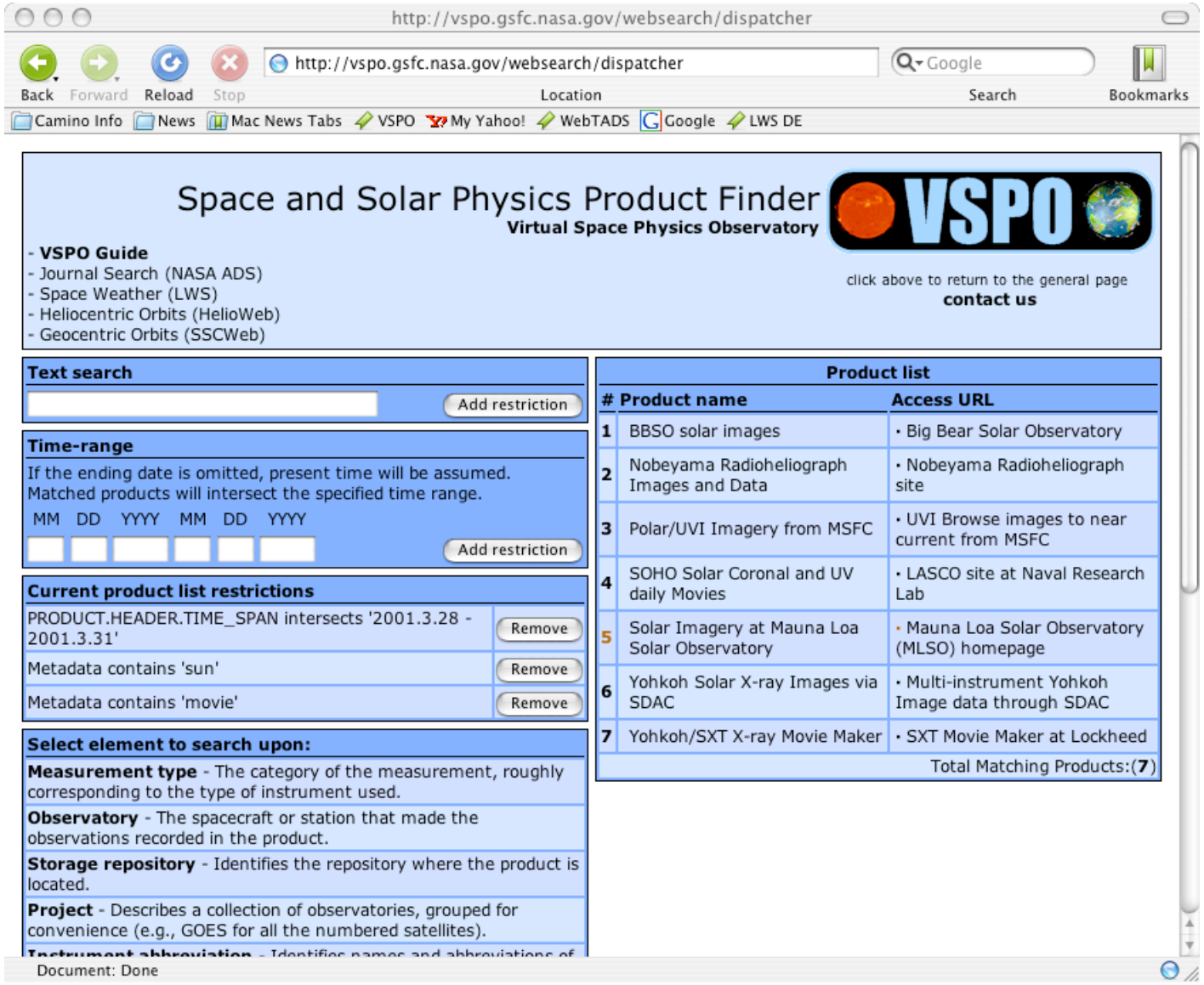
Back Forward Reload Stop http://www.sec.noaa.gov/ftpdir/plots/20 Location Google Search Bookmarks

Camino Info News Mac News Tabs VSPO My Yahoo! WebTADS Google LWS DE



Updated 2001 Mar 30 23:56:04 UTC NOAA/SEC Boulder, CO USA

Document: Done


http://vspo.gsfc.nasa.gov/websearch/dispatcher
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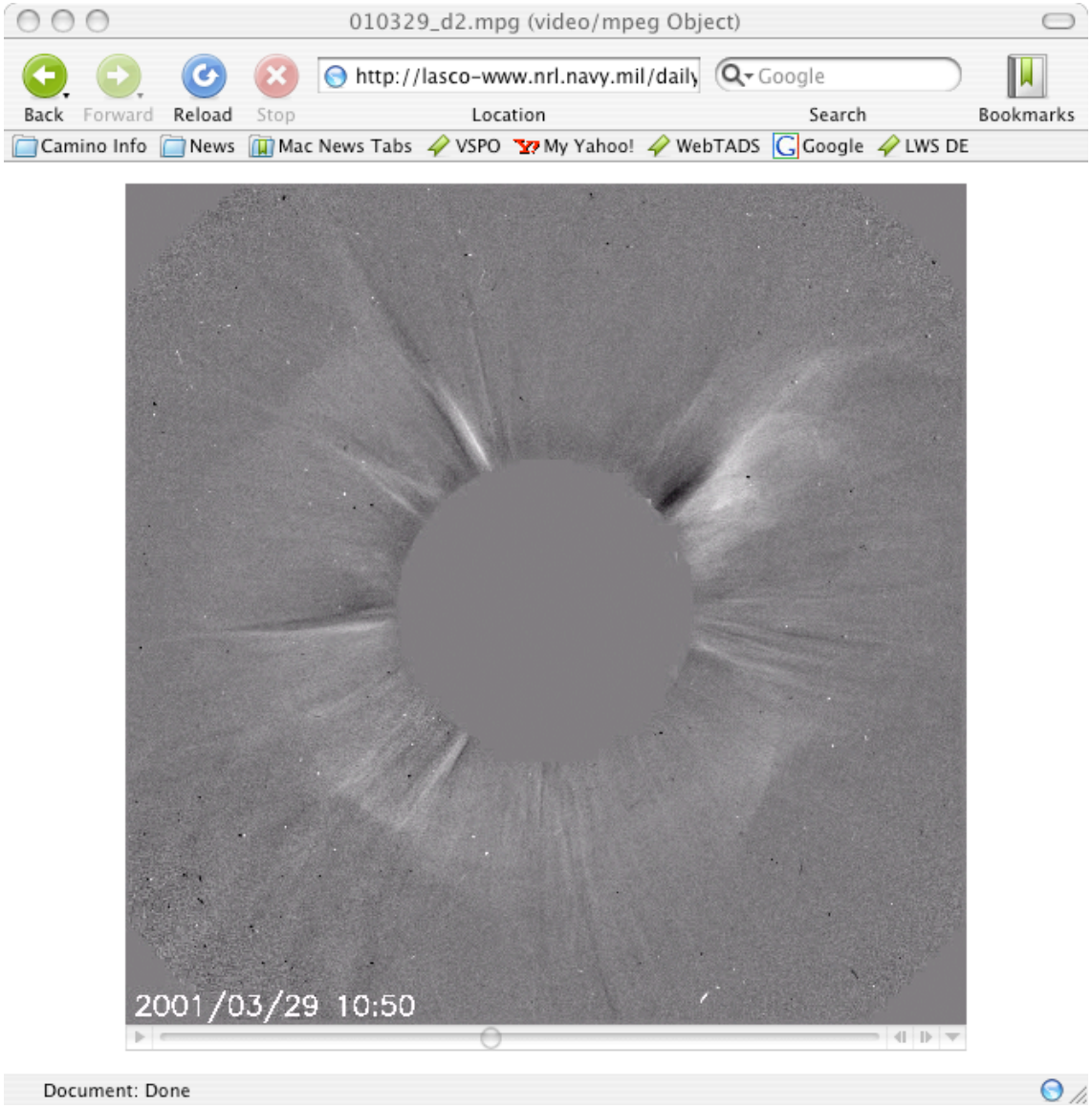
http://vspo.gsfc.nasa.gov/websearch/dispatcher
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
Space and Solar Physics Product Finder
Virtual Space Physics Observatory
VSPO
- VSPO Guide
- Journal Search (NASA ADS)
- Space Weather (LWS)
- Heliocentric Orbits (HelioWeb)
- Geocentric Orbits (SSCWeb)
click above to return to the general page
contact us
Text search
Add restriction
Time-range
If the ending date is omitted, present time will be assumed.
Matched products will intersect the specified time range.
MM DD YYYY MM DD YYYY
Add restriction
Current product list restrictions
PRODUCT.HEADER.TIME_SPAN intersects '2001.3.28 - 2001.3.31'
Remove
Metadata contains 'sun'
Remove
Metadata contains 'movie'
Remove
Select element to search upon:
Measurement type - The category of the measurement, roughly corresponding to the type of instrument used.
Observatory - The spacecraft or station that made the observations recorded in the product.
Storage repository - Identifies the repository where the product is located.
Project - Describes a collection of observatories, grouped for convenience (e.g., GOES for all the numbered satellites).
Product list
Product name
Access URL
1 BBSO solar images
• Big Bear Solar Observatory
2 Nobeyama Radioheliograph Images and Data
• Nobeyama Radioheliograph site
3 Polar/UVI Imagery from MSFC
• UVI Browse images to near current from MSFC
4 SOHO Solar Coronal and UV daily Movies
• LASCO site at Naval Research Lab
5 Solar Imagery at Mauna Loa Solar Observatory
• Mauna Loa Solar Observatory (MLSO) homepage
6 Yohkoh Solar X-ray Images via SDAC
• Multi-instrument Yohkoh Image data through SDAC
7 Yohkoh/SXT X-ray Movie Maker
• SXT Movie Maker at Lockheed
Total Matching Products:(7)
Document: Done

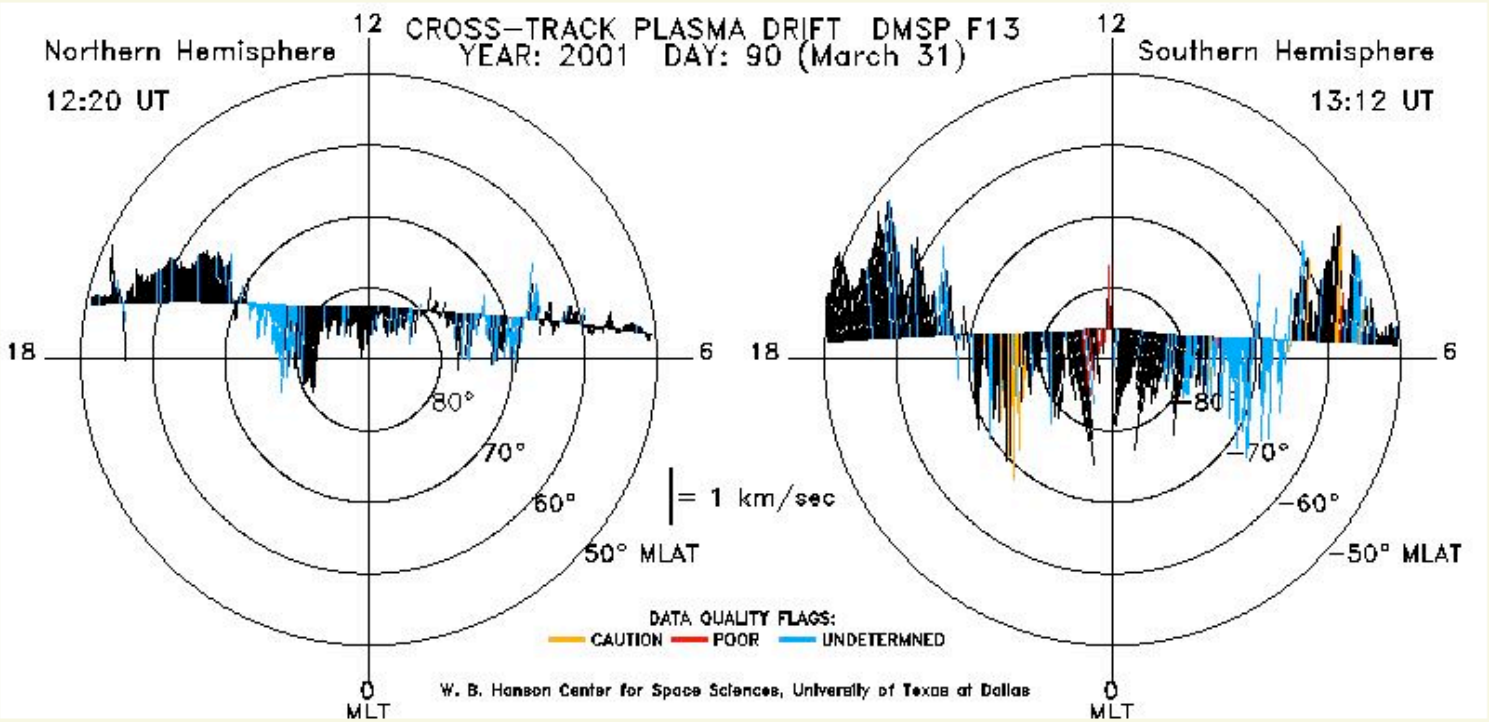

010329_d2.mpg (video/mpeg Object)
Back
Forward
Reload
Stop
http://lasco-www.nrl.navy.mil/daily
Location
Google
Search
Bookmarks
Camino Info
News
Mac News Tabs
VSPO
My Yahoo!
WebTADS
Google
LWS DE
2001/03/29 10:50
Document: Done

DMSP SSIES Data Polar Plot

Back Forward Reload Stop http://cindispace.utdallas.edu/cgi-bin/DMSP/polar_plot.cgi/f13_rl010 Location Google Search Bookmarks

Camino Info News Mac News Tabs VSPO My Yahoo! WebTADS Google LWS DE

DMSP SSIES Polar Plot of Cross-Track Plasma Drift



Search Again

Document: Done

plr20010329.jpeg (JPEG Image, 4

Back Forward Reload Stop

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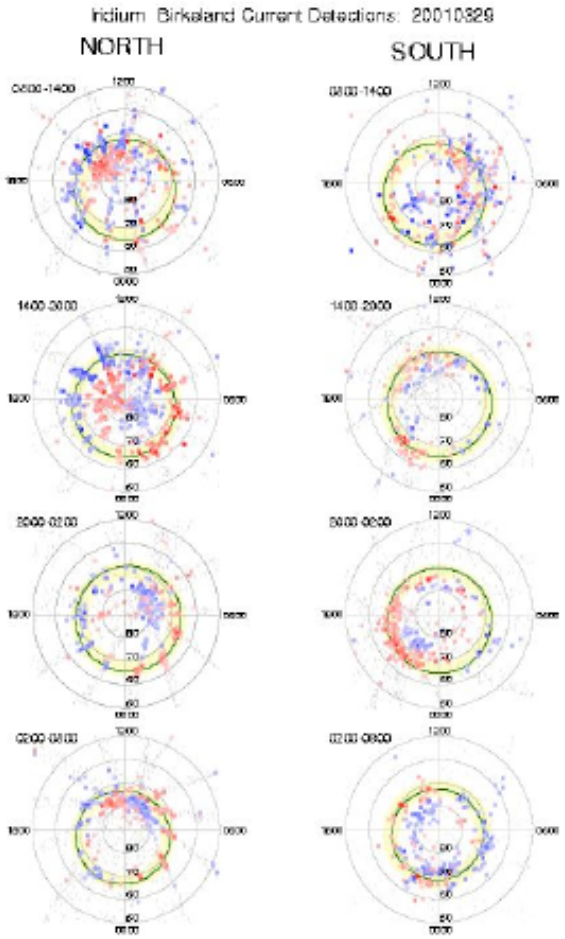

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plr20010331.jpeg (JPEG Image, 4

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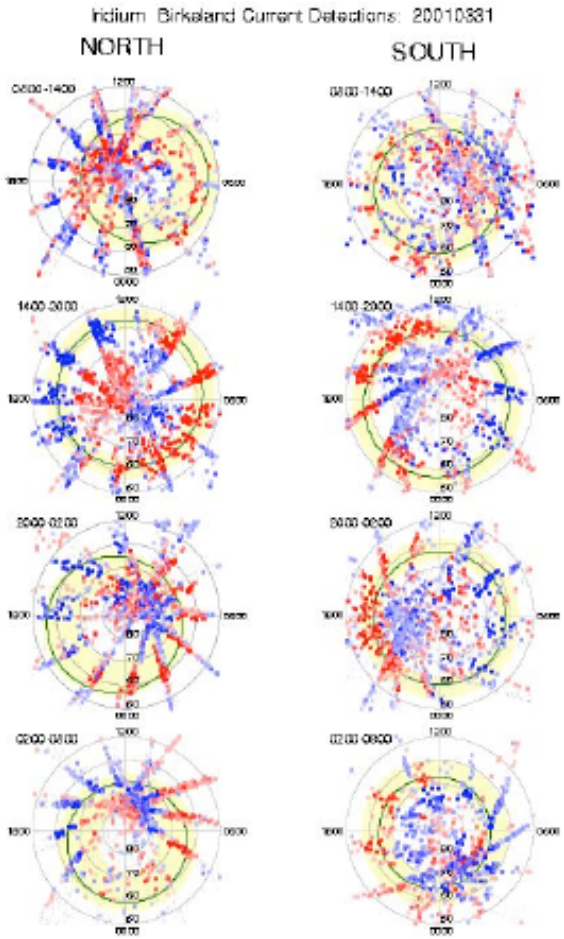

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Geotail Daily KP Survey

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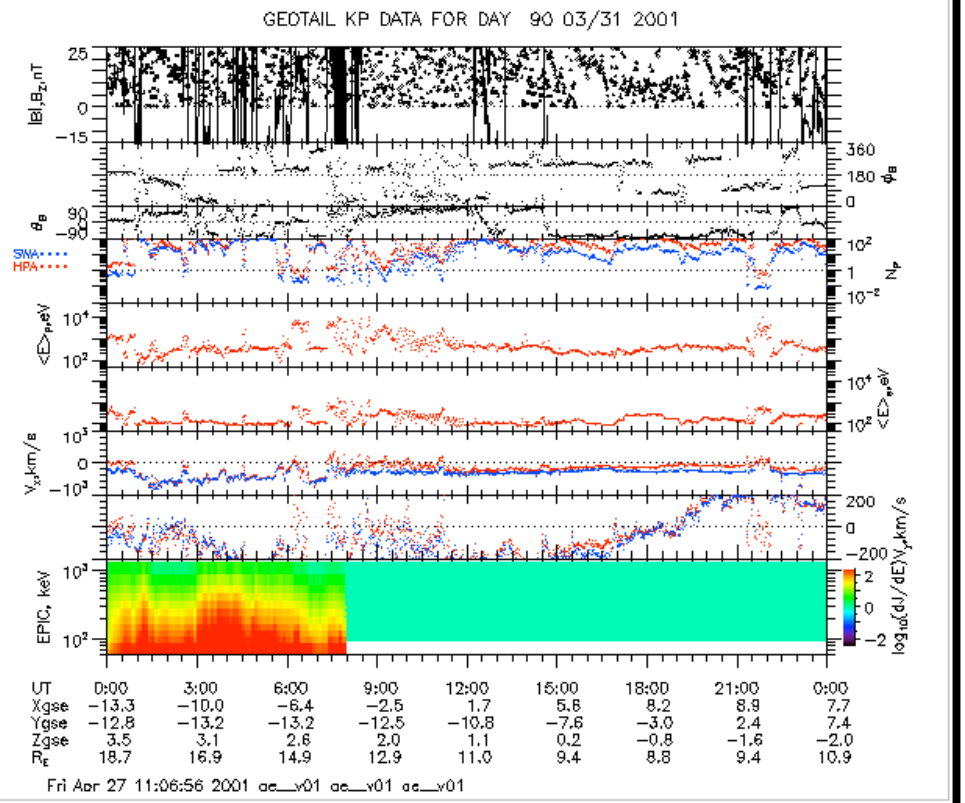
Geotail Daily KP Survey



Previous	Date	Next	Plot Type
◀	Date: 20010331	▶	Geotail Daily KP Survey

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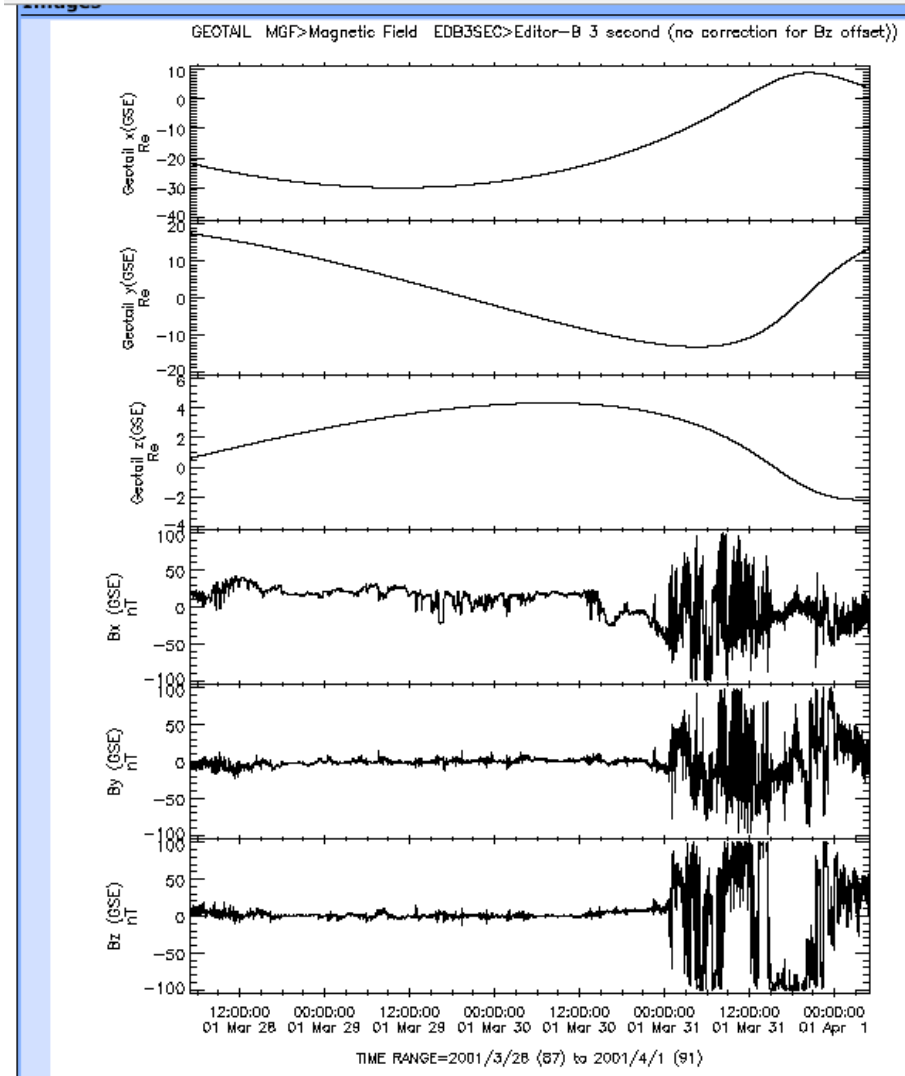
CDAW accessor results



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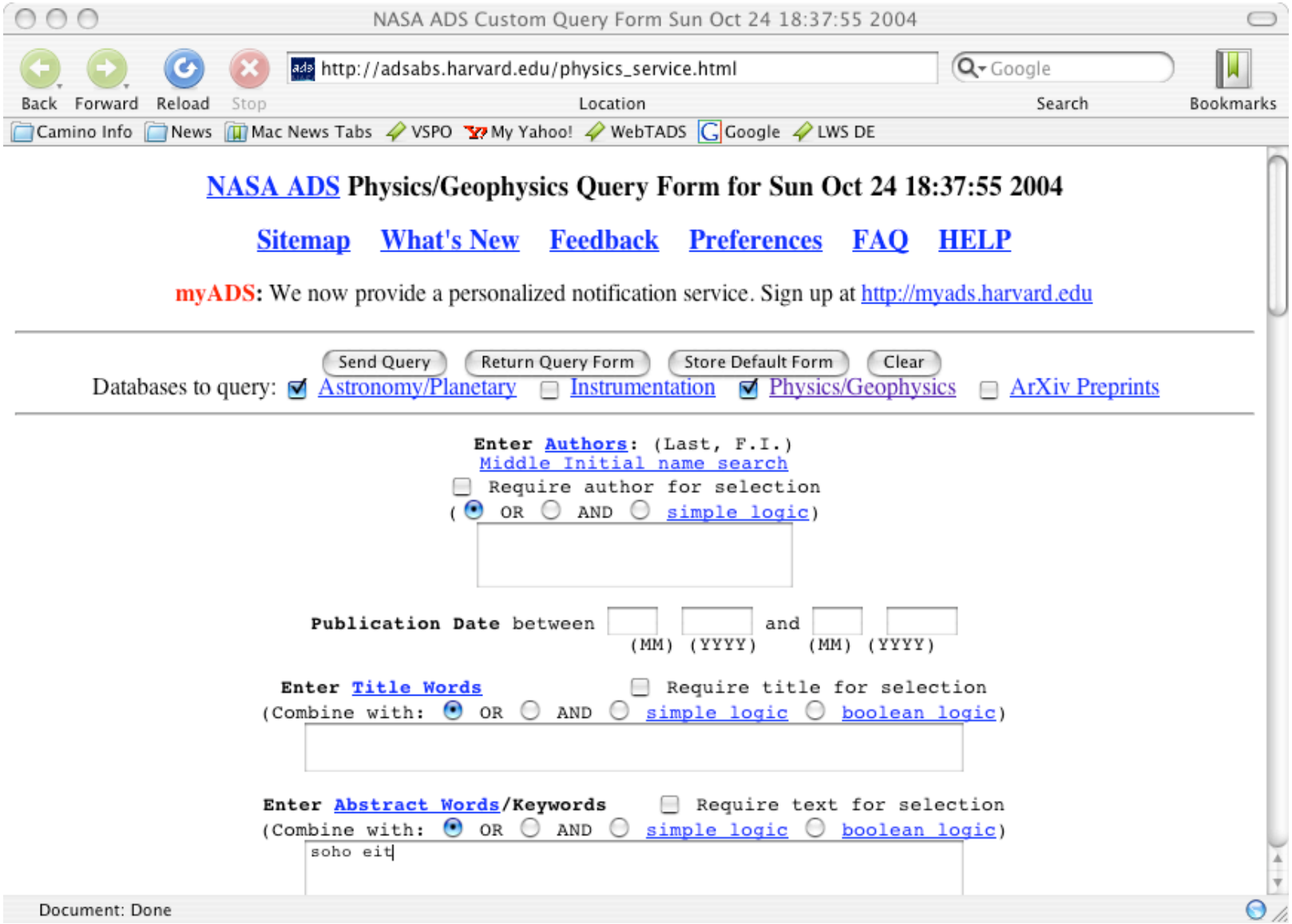
NASA ADS Custom Query Form Sun Oct 24 18:37:55 2004
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NASA ADS Physics/Geophysics Query Form for Sun Oct 24 18:37:55 2004
Sitemap
What's New
Feedback
Preferences
FAQ
HELP
myADS: We now provide a personalized notification service. Sign up at http://myads.harvard.edu
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Return Query Form
Store Default Form
Clear
Databases to query:
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Require author for selection
(OR AND simple logic)
Publication Date between
(MM) (YYYY) and (MM) (YYYY)
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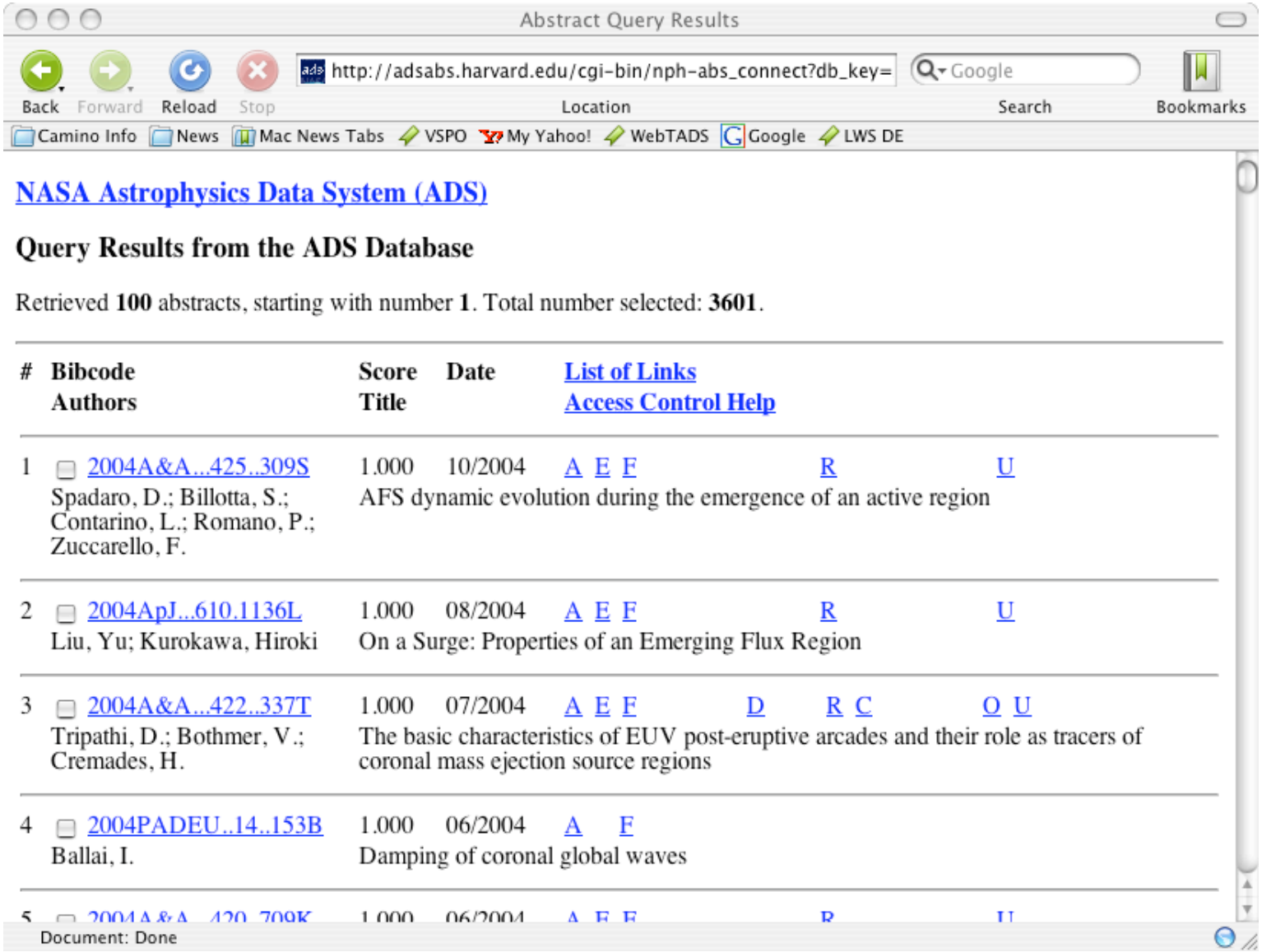
Abstract Query Results
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NASA Astrophysics Data System (ADS)
Query Results from the ADS Database
Retrieved 100 abstracts, starting with number 1. Total number selected: 3601.
Bibcode Authors Score Title Date List of Links Access Control Help
1 2004A&A...425..309S 1.000 10/2004 A E F R U
Spadaro, D.; Billotta, S.; Contarino, L.; Romano, P.; Zuccarello, F.
AFS dynamic evolution during the emergence of an active region
2 2004ApJ...610.1136L 1.000 08/2004 A E F R U
Liu, Yu; Kurokawa, Hiroki
On a Surge: Properties of an Emerging Flux Region
3 2004A&A...422..337T 1.000 07/2004 A E F D R C O U
Tripathi, D.; Bothmer, V.; Cremades, H.
The basic characteristics of EUV post-eruptive arcades and their role as tracers of coronal mass ejection source regions
4 2004PADEU..14..153B 1.000 06/2004 A F
Ballai, I.
Damping of coronal global waves
5 2004A&A...420..709K 1.000 06/2004 A E F R U
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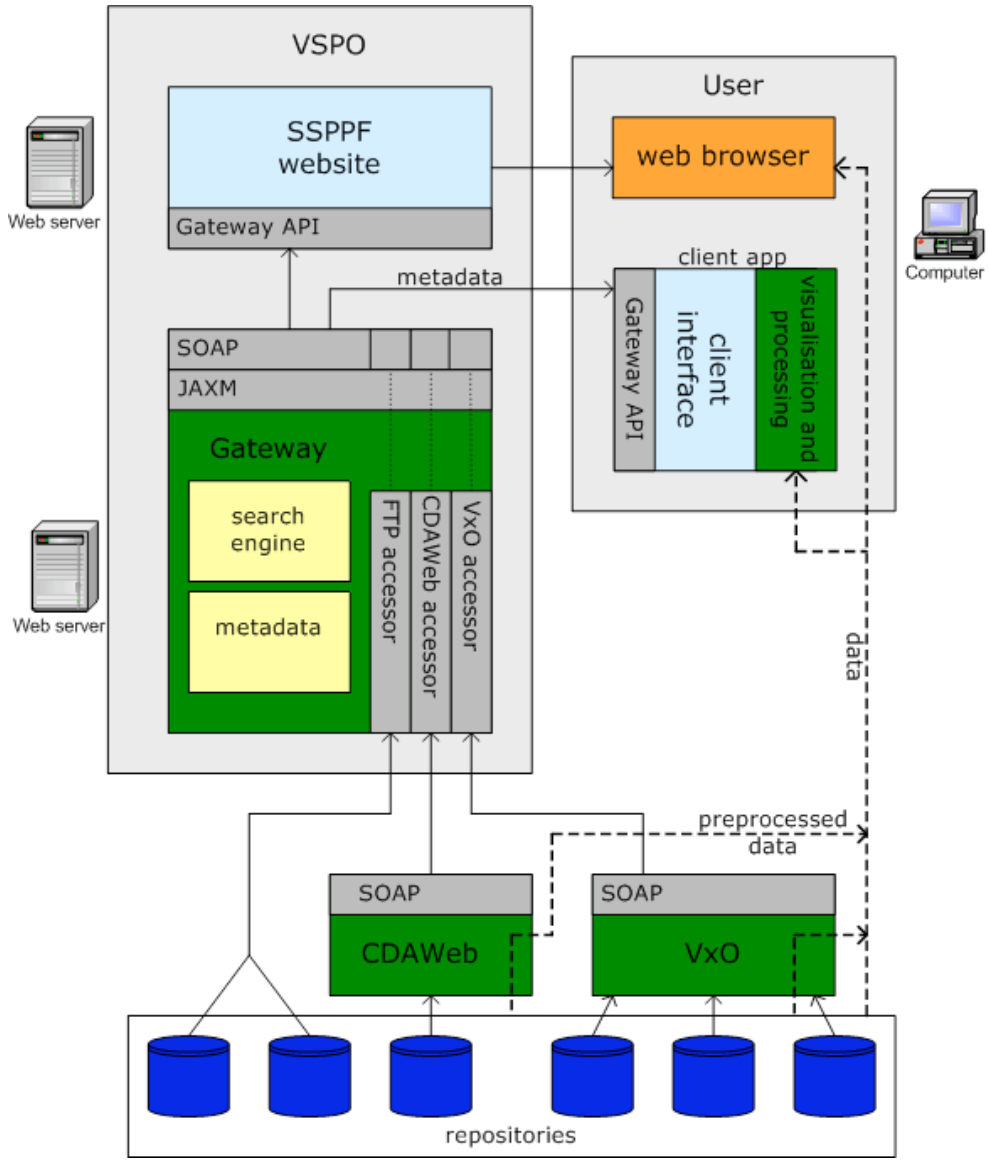
VSPO
SSPPF
website
Gateway API
Web server
metadata
SOAP
JAXM
Gateway
search
engine
metadata
FTP accessor
CDAWeb accessor
VxO accessor
Web server
User
web browser
client app
Gateway API
client
interface
visualisation and
processing
Computer
data
preprocessed
data
SOAP
CDAWeb
SOAP
VxO
repositories

```
<?xml version="1.0"?>
<!-- edited with XMLSPY v2004 rel. 3 U (http://www.xmlspy.com) by Vasili Rezapkin (AQUILENT) -->
<!DOCTYPE dictionary SYSTEM "dictionary.dtd">
<dictionary>
    <element name="PRODUCT" display="Product">
        <content/>
        <children>
            <child_element name="HEADER" required="yes" allow_multiple="no"/>
            <child_element name="TIME_SERIES" required="no" allow_multiple="yes"/>
        </children>
    </element>
    <element name="HEADER" display="Header">
        <content/>
        <children>
            <child_element name="PRODUCT_NAME" required="yes" allow_multiple="no"/>
            <child_element name="PRODUCT_DESCRIPTION" required="yes" allow_multiple="no"/>
            <child_element name="CONTACT_INFORMATION" required="no" allow_multiple="no"/>
            <child_element name="INSTRUMENT_ABBREVIATION" required="no" allow_multiple="yes"/>
            <child_element name="ACCESS_URL" required="no" allow_multiple="yes"/>
            <child_element name="REPOSITORY" required="yes" allow_multiple="no"/>
            <child_element name="PRODUCT_TYPE" required="yes" allow_multiple="yes"/>
            <child_element name="OBSERVATORY_REGION" required="no" allow_multiple="yes"/>
            <child_element name="OBSERVED_REGION" required="no" allow_multiple="yes"/>
            <child_element name="PROJECT" required="no" allow_multiple="yes"/>
            <child_element name="OBSERVATORY" required="no" allow_multiple="yes"/>
            <child_element name="MEASURMENT_TYPE" required="no" allow_multiple="yes"/>
            <child_element name="PROCESSING_LEVEL" required="no" allow_multiple="yes"/>
            <child_element name="ACCESS_RIGHTS" required="no" allow_multiple="no"/>
            <child_element name="AVAILABILITY_STATUS" required="no" allow_multiple="no"/>
            <child_element name="FORMAT" required="no" allow_multiple="yes"/>
            <child_element name="RESOLUTION" required="no" allow_multiple="no"/>
            <child_element name="CADENCE" required="no" allow_multiple="no"/>
            <child_element name="TIME_SPAN" required="no" allow_multiple="no"/>
            <child_element name="DATA_CURRENCY" required="no" allow_multiple="no"/>
            <child_element name="MEASUREMENT_DURATION" required="no" allow_multiple="no"/>
            <child_element name="CAVEATS" required="no" allow_multiple="no"/>
        </children>
    </element>
    <element name="DATA_CURRENCY" display="Data currency" description="The expected time lag between c
        <content>
            <string maxlen="500"/>
        </content>
        <children/>
    </element>
    <element name="PRODUCT_NAME" display="Product name" description="A short, unique description of a
        <content>
            <string maxlen="100"/>
        </content>
        <children/>
    </element>
```

```
<?xml version="1.0"?>
<!DOCTYPE product SYSTEM "product.dtd">
<product>
    <elm name = "PRODUCT">
        <elm name = "HEADER">
            <elm name = "PRODUCT_NAME">
                <string value = "OMNI"/>
            </elm>
            <elm name = "PRODUCT_DESCRIPTION">
                <string value = "Hourly near-Earth solar wind magnetic field, plasma and energetic pa
            </elm>
            <elm name = "CONTACT_INFORMATION">
                <string value = "Natalia Papitashvili, GSFC/NSSDC, Natasha@mail630.gsfc.nasa.gov"/>
            </elm>
            <elm name = "INSTRUMENT_ABBREVIATION">
                <string value = "SWE"/>
            </elm>
            <elm name = "INSTRUMENT_ABBREVIATION">
                <string value = "SWEPAM"/>
            </elm>
            <elm name = "INSTRUMENT_ABBREVIATION">
                <string value = "MFI"/>
            </elm>
            <elm name = "INSTRUMENT_ABBREVIATION">
                <string value = "MAG"/>
            </elm>
            <elm name = "ACCESS_URL">
                <url value = "http://nssdc.gsfc.nasa.gov/omniweb" description="Yet another test"/>
            </elm>
            <elm name = "REPOSITORY">
                <id value = "NSSDC"/>
            </elm>
            <elm name = "PRODUCT_TYPE">
                <id value = "DATA"/>
            </elm>
            <elm name = "OBSERVATORY_REGION">
                <id value = "L1"/>
            </elm>
            <elm name = "OBSERVATORY">
                <id value = "ACE"/>
            </elm>
            <elm name = "OBSERVATORY">
```

```
<elm name = "TIME_SERIES">
    <elm name = "PHYSICAL_QUANTITY">
        <id value = "MAG_FLD"/>
    </elm>
    <elm name = "QUALIFIER">
        <id value = "COMPONENT"/>
    </elm>
    <elm name = "QUALIFIER">
        <id value = "X"/>
    </elm>
    <elm name = "COORDINATE_SYSTEM">
        <id value = "GSE"/>
    </elm>
    <elm name = "UNIT">
        <unit value = "NT"/>
    </elm>
    <elm name = "TIME_SERIES_DESCRIPTION">
        <string value = "GSE (and GSM) X component of hour-averaged magnetic field"/>
    </elm>
    <elm name = "ENTITY">
        <id value = "FIELD"/>
    </elm>
    <elm name = "RESOLUTION">
        <number_real value = "3600."/>
    </elm>
</elm>
<elm name = "TIME_SERIES">
    <elm name = "PHYSICAL_QUANTITY">
        <id value = "MAG_FLD"/>
    </elm>
    <elm name = "QUALIFIER">
        <id value = "COMPONENT"/>
    </elm>
    <elm name = "QUALIFIER">
        <id value = "Y"/>
    </elm>
    <elm name = "COORDINATE_SYSTEM">
```

Future Directions

- Add more accessors for “ordered” ftp sites.
- Add more accessors for VSO and other products when the APIs are available.
- Continue to add products.
- Develop metadata management software.
- Provide an API for access from applications.
- Produce a companion higher-order query service based on event lists and modest resolution data sets held and manipulated in RAM.